HORTICULTURAL ADAPTATION AND ECOLOGICAL CHANGE IN SOUTHWESTERN O'AHU: PRELIMINARY EVIDENCE FROM BARBERS POINT

Bertell D. Davis
Department of Anthropology
University of Hawaii at Manoa
Honolulu, Hawaii 96822

INTRODUCTION

> From these shores we were visited by some of the natives, in the most wretched canoes I had yet seen amongst the South-Sea islands; they corresponded however with the appearance of the country, which from the commencement of the high land to the westward of Opooroah (Pu'uloa), was composed of one very barren rocky waste, nearly destitute of verdure, cultivation of inhabitants, with little variation all the way to the west point of the island (Vancouver 1798, II:217).

It is evident from Vancouver's rather bleak description that the 'Ewa Plain in southwestern O'ahu did not support a forest habitat at the time of European contact. Yet within the next century the introduced kiawe (Prosopis sp.) had spread so extensively across the plain that the region became a major source of firewood for the kitchens of Honolulu.

There has been a tendency among biologists and other researchers interested in Pacific island ecosystems to assume that environmental changes of such magnitude occurred only following European contact, and that the prehistoric human inhabitants of these islands had relatively little impact upon their environment. Considerable evidence is now accumulating that prehistoric man was in fact a significant force for ecological change in Hawai'i and other Pacific island groups. His persistent transformation of the landscape for agricultural purposes was particularly devastating in the lowlands where the expansion of irrigation and dry-field systems often culminated in the near total replacement of the native forest. Much of this land conversion undoubtedly involved the use of fire in what Spencer (1966) has characterized as "pioneer swiddening". Fire was probably also used to promote desired habitats, for instance, grasslands to supply thatching material for house construction. In both cases it is likely that unintentional burns from "controlled" fires periodically escaping into adjacent areas led to the decline of existing habitats.

In Hawai'i, episodes of widespread burning during the prehistoric period have been documented on Kaho'olawe and Molokai. The evidence from Halawa Valley on Molokai suggests that shifting cultivation, possibly using

slash-and-burn techniques, preceded the development of more permanent agricultural systems (Kirch and Kelly 1975; Riley 1973). On Kaho'olawe, burn layers found in erosional cuts and in excavations also point to the use of fire in the uplands for expanding agricultural fields, and probably for reclaiming fallow lands as well (Hommon 1980). There is a significant difference, however, between the Kaho'olawe data and that from Molokai. Productive use of the irrigated taro lands in Halawa Valley continued well into historic times. In contrast, the burn layers and associated agricultural features on Kaho'olawe are frequently buried under massive alluvial and colluvial deposits suggesting that cultural modifications of the landscape led to the eventual degradation of the island's environment and subsequent decline of its human population prior to the historic period.

Although horticultural developments may have been considerably restricted in less favorable regions of the islands, the ultimate effects of environmental modification were no less profound. Recent excavations at Barbers Point in southwestern O'ahu confirm that dispersed small-scale gardens were an integral component of the local settlement. Once established, productive cultivation probably involved little more then an intensification of already well tested methods for developing suitable soil conditions and conserving available moisture. Nonetheless, the excavation data also suggest that even these seemingly modest transformations may have contributed significantly to the extinction of a once diverse avifauna and land snail community in the region.

THE EVIDENCE FOR SMALL-SCALE GARDENING

The Setting

The Barbers Point study area is located on the far western coast of the 'Ewa coral plain. Alluviation from the Wai'anae uplands covers the inland portion of the plain. The coralline substrate in the coastal zone remains exposed and has weathered to form a shallow karst landscape with poor soil development. There is a semi-arid region of intense sunshine, persistent tradewinds, and low annual rainfall. While perhaps not as pronounced as elsewhere on the island, seasonal variation does occur with much of the rain coming during the cooler winter months. During periods of heavy kona storms the combined runoff from the inland zone can produce extensive sheet-wash flooding at the coast. This was particularly evident this past season when unchannelled water was observed running 30cm and higher over the limestone surface.

The vegetation in undeveloped areas of the region is typically xeric. Historical sources and relictual occurrances of native plants in the modern flora suggest that the aboriginal vegetation was likely an open grassland, or a savannah dotted with wiliwili (Erythrina sandwicensis) and other xerophytic trees (Char and Balakrishnan 1979; Frierson 1971; Lewis 1970). That species adapted to wetter conditions can actually thrive in the region is indicated by the persistence of noni (Morinda citrifolia) and ti (Cordyline terminalis) throughout the study area where they found growing in the deeper sinkholes, presumably tapping the local water table. Both were

important plants in traditional Hawaiian economy and were probably introduced into the region by the former residents

The Problem

The early Hawaiian settlers at Barbers Point probably considered the area as relatively marginal for agricultural purposes. Nevertheless, the large number of structurally modified sinkholes and shallow sediment-filled depressions, reminiscent of protective windbreak-enclosures and mulched pit gardens found elsewhere in Hawai'i (Handy and Handy 1972; Newman 1970) and in the tropical Pacific (Barrau 1961; McCoy 1976), suggested that some form of plant cultivation had been practiced in the area (Davis and Griffin 1978; Sinoto 1976). Subsequent archaeological surveys have recorded similar features at 'Ewa Beach indicating the practice was fairly widespread (Davis 1980). Locational analysis of the survey data from Barbers Point and 'Ewa Beach showed that many of the habitation sites, both single dwellings and residential aggregates, were apparently situated intentionally amid or adjacent to clusters of these modified sinks and depressions. Conversely, although probable task-specific occupation shelters were found somewhat removed from the main habitation areas, few of the inferred horticultural features were found isolated from the residence areas. To what extent this may reflect skewness in the data because of recent disturbances in the area is unknown at this time.

In addition to the modified sinkholes and depressions, plants may also have been cultivated in or along the margins of low-lying wetlands near the coast. Three marshes still exist in the region: two at Barbers Point and the other at 'Ewa Beach. The latter is apparently the largest surviving marshland in southwestern O'ahu, and it seems to be the least disturbed by modern developments. Approximately sixty archaeological features, including numerous house sites, appear to be intentionally located around the periphery of the marsh (Davis 1980). The implications of this are as yet uncertain, but it does suggest that the marsh may have been more like an open pond during prehistoric times, and was perhaps functionally integrated into the local subsistence system. A similar association was recorded between Hawaiian house sites and one of the marshes at Barbers Point (Lewis 1970).

The Excavations

During 1980-81, excavations were conducted in a cluster of 34 individual features inferred to be a relatively intact horticultural complex. This cluster was designated Site Complex 2717 and is located at the north end of the Barbers Point study area (see Davis and Griffin 1978:152-157, for a complete description and inventory of this site). Six features were excavated, including a habitation structure, a natural well, and four inferred garden pits.

Site 2717-1 was a medium-sized C-shape (in plan view) habitation structure of approximately $15m^2$, defined by a multiple-stacked stone wall with an interior facing of large stone slabs set on edge. As with all previously excavated structures at Barbers Point, the wall is built entirely

of the local limestone and served as the foundation for a pole-and-thatch superstructure. The wall is situated on the northeast side of the living floor with the open side oriented to the leeward of the prevailing winds. This corresponds well with the analysis of wall orientation in other C-shape habitation structures in the study area (Davis and Griffin 1978:184). The excavation results may be summarized as follows: (a) the floor deposit was small, less than $10m^2$, and confined largely to the interior of the structure; (b) there were no spatially differentiated activity areas in the deposit; (c) food refuse was rather minimal and was concentrated mainly in the interior floor; (d) there was little evidence of burning in the site, either in the form of hearths or of charcoal blackening of the deposit; and finally; (e) there were no portable artifacts, including the usually ubiquitous flakes of volcanic glass. In sum, the evidence indicates a short-term use of the structure, probably as a temporary field shelter for the cultivator(s) tending the nearby gardens.

Site 2717-2 is a large modified sinkhole immediately adjacent to the habitation structure (2717-1). The sink is about 3m deep, with an opening approximately 1.5m in diameter at ground surface and an interior floor of nearly $6m^2$. The surface opening is partially enclosed by a free-standing C-shape wall built of limestone in a manner very much like the habitation site, and quite unlike the enclosing walls of the presumed garden features. This suggests that the wall around this sink may have served as the foundation for a pole-and-thatch superstructure similar to that inferred for the habitation feature. The edge of the opening also seems to have been chipped or worn smooth making access to the interior relatively easy. Together this suggested that the sink may have been a natural well tapping a previously higher water table: a hypothesis provisionally confirmed by the discovery of several overlapping bowl-shaped pits which had been dug into the interior floor of the sink. In the excavation profiles these pits were relatively consistent in size and depth and, in two cases, contained fine clay-like lenses at the bottom of the pits. It is possible that water was available here only seasonally, and then probably only during periods of high tide. If so, then despite the relatively greater depth of this sink compared to others in the cluster, a roof over the sink may have been necessary to reduce evaporation. Unfortunately the excavation did not reach the modern water table which is still accessible through several other sinkholes at Barbers Point.

Sites 2717-4 and 2717-5 are both walled depressions of approximately $25m^2$ and $30m^2$ in area, respectively. Site 2717-4 was originally described as "apparently a large, shallow dirt-filled sinkhole walled on all sides by [a] simple alignment of limestone boulders and slabs set on edge" (Davis and Griffin 1978:156). Site 2717-5 was similarly described. Because there may have been potentially important differences in moisture retention and mulching techniques, it was important to determine if in fact these were sinkholes with deeper and more porous fill than initially considered, or if these were shallow basins in the bedrock surface with the sediments resting on a hard rock bottom.

Excavation confirmed that these were not sinkholes, but hard-bottomed depressions with a smooth, extremely dense "veneered" surface of precipitated carbonate much like travertine. The sediments from these features have not yet been analyzed in the laboratory, but in the

stratigraphic sections there are two distinct units below the modern organic overburden. The first unit averages 10-20cm thick and appears to be an anthropogenic soil horizon. It is characterized especially by (a) its relative organic content and degree of aeration and homogenization not generally observed in "natural" root zones at Barbers Point, and (b) the presence of the land snail Lamellaxis gracilis in the anthropogenic horizon in contrast to its conspicuous absence from the stratigraphically lower unmodified sediments. In general, the lower unit is a finer-grained and more compacted material containing few land snails visible to the naked eye. Those that were observed were at or just below the interface with the upper unit.

Site 2717-7 was a walled sinkhole of only about $5m^2$. The excavation bottomed out on large limestone boulders without reaching bedrock. However, the soil profile showed the same, albeit not nearly so well developed, anthropogenic horizon directly under the modern organic overburden. Lying below this soil horizon was a progressively (with depth) stonier unmodified sediment.

Site 2717-34 had not been recorded previously and it proved to be quite a different kind of feature. There was no encircling stone wall; the only indication that this may have been a garden plot was a rather noticeable lack of loose surface rocks. The excavation showed that this was a considerably larger and deeper depression than the two described above, but the excavation bottomed out on the same kind of "veneered" bedrock. The soil profile also appeared more similar to that in the other depressions than that in the sinkhole. As for the lack of an enclosing wall, the interior surface of this feature is nearly as deep below ground surface as the walls are in average height. It is therefore possible that a protective windbreak was unnecessary.

Summary

A number of salient points bear reviewing here. First of all, Site Complex 2717 appears to be primarily a gardening area, including a natural well as a source of fresh water and a field shelter to provide the gardeners with temporary cover when needed. Because of extensive disturbances around this cluster, however, the possible habitation area(s) that may have been associated with these gardens was not found. Finally, although the evidence for plant cultivation appears quite good, the excavations did not recover any noticeable evidence for the use of fire in land clearance. If the area had originally been an open grassland or savannah, then fire may have been unnecessary for clearing land or for maintaining desired habitats. As for the possible use of the wetland areas for plant cultivation, no information is available as yet--although fieldwork is currently under way.

THE EVIDENCE FOR ECOLOGICAL CHANGE

Over the past decade, Barbers Point and the wider 'Ewa Plain have become a center of scientific interest with both local and international

significance. This is principally due to the discovery of the remains of a once diverse avifauna and land snail community in the region. Olson and James (in press) note the occurrence of an "extraordinary period of extinction within relatively recent time [and that] fossils have contributed no less than 38 extinct species of endemic land birds that are unknown historically." Many of these came from Barbers Point which also yielded the remains of sea birds now found in only a few restricted localities. Kirch and Christensen (1981) have documented similar trends among native land snail populations at Barbers Point.

The extinction of both the avifauna and the land snails appears to be a contemporaneous phenomena that occurred over a comparatively short period of time. Until recently, a major limitation of the data has been the lack of a secure chronology. The paucity of absolute dates continues to be a problem. However, several lines of evidence now confirm that at least some of the extinct species were still present in the Barbers Point region during the period of Hawaiian settlement.

First of all, excavations by Pat McCoy in a rock-shelter habitation site at Barbers Point recovered the charred bones of a large nene-like goose from a hearth. Charcoal from the same hearth has been dated to ca. A.D. 1200 (Olson and James, in press).

Secondly, an analysis of land snail samples by Kirch and Christensen (1981) has identified the stratigraphic co-occurrence of prehistoric adventive animal species (the Polynesian rat, various lizards, and the land snail Lamellaxis gracilis) with the remains of both extinct land snails and extinct birds.

Finally, my own work in Site Complex 2717 identified similar co-occurrences of prehistoric adventive species with extinct species in the fill of the bowl-shaped pits dug into the bottom of the well (Site 2717-2). More recently, excavations undertaken in a large residential complex recovered the remains of the locally extinct Hawaiian petrel from apparently intact cultural deposits (Davis ms.). This line of evidence is very tentative, however, because previous evidence for a direct association between the extinct birds and cultural remains has always been uncertain or questionable--principally because natural processes which may have altered the original context could not be satisfactorily discounted.*

* Excavations currently in progress at Barbers Point confirm the direct stratigraphic association between the remains of seabirds (probably the Hawaiian petrel) and cultural refuse. In this case, the bones are both burned and splintered indicating the birds had been exploited for food.

CONCLUSIONS

Although detailed analysis of the excavated material has yet to be completed, it is clear from the foregoing that (a) the prehistoric Hawaiian settlers at Barbers Point did practice some form of plant cultivation; (b) conditions changed in the region which led to the extinction of a significant portion of the local avian and land snail population; and (c) at least some of the extinct species survived into the period of Hawaiian settlement in the region, but not into the historic period. However, causal relationships in this chain of events have yet to be demonstrated, and this returns to the problem of chronology discussed above.

The range of available dates indicate a span of human settlement at Barbers Point from ca. A.D. 1200-1870. But only two sites have been dated earlier than A.D. 1600: the rock shelter excavated by McCoy, and a walled house site (adjacent to the marsh recorded by Lewis in 1970) excavated by Hammatt and Folk (1981). Occupation of the remaining sites for which we have dates falls within the last 300 years of the sequence, and these are all surface habitation structures. It may be that initial use of the region involved only limited residence in "ecologically optimal" areas, such as large rock shelters or inland marshes, with the more extensive habitation located along the shoreline, and that the expansion of the inland habitation areas did not occur until the sixteenth or seventeenth centuries. If so, then significant horticultural developments and the changes they may have precipitated may also have been equally late.

LITERATURE CITED

Barrau, J. 1961. Subsistence agriculture in Polynesian and Micronesia. B.P. Bishop Museum Bulletin 223.

Char, W.P., and N. Balakrishnan. 1979. 'Ewa Plains botanical study. Manuscript report for U.S. Department of Interior, Fish and Wildlife Service (Contract No. 14-16-0001-78171). Honolulu.

Davis, B.D. 1980. Report on archaeological survey of the proposed Ewa marina community development, Ewa Beach, Oahu Island. Hawaii Marine Research Inc., Manuscript Report. Honolulu.

_____. ms. Progress report on emergency excavations at Barbers Point, Oahu: Third season, 1981. In preparation.

Davis, B.D., and P.B. Griffin (eds.). 1978. Studies in natural history and human settlement at Barbers Point, Oahu. Interim Report I. Archaeological Research Center Hawaii Manuscript Report 14-1151. Lawai, Kauai.

Frierson, B. 1972. A study of land use and vegetation change: Honouliuli, 1790-1925. Manuscript prepared for graduate seminar in Geography (750), University of Hawaii at Manoa. Honolulu.

Hammatt, H.H. and W.H. Folk. 1981. Archaeological and paleontological investigation at Kalaeloa (Barbers Point), Honouliuli, 'Ewa, O'ahu: Federal Study Areas 1a and 1b, and State of Hawaii Optional Area 1. Archaeological Research Center Hawaii Manuscript Repott 14-115II. Lawai, Kauai.

Handy, E.S.C., and E.G. Handy. 1972. Native planters in old Hawaii: life, lore, and environment. B.P. Bishop Museum Bulletin 233.

Hommon, R.J. 1980. Historic resources of Kahoolawe: The National Register multiple resources nomination overview. Prepared for U.S. Navy, Pacific Division (Contract No. N672742-78-C-0061). Honolulu.

Kirch, P.V., and C.C. Christensen. 1981. Nonmarine molluscs and paleo-ecology at Barbers Point, O'ahu. Appendix II in H.H. Hammatt and W.H. Folk, Archaeological and paleontological investigation at Kalaeloa (Barbers Point), Honouliuli, 'Ewa, O'ahu: Federal Study Areas 1a and 1b, and State of Hawaii Optional Area 1. Archaeological Research Center Hawaii Manuscript Report 14-115II. Lawai, Kauai.

_____, and M. Kelly (eds.). 1975. Prehistory and ecology in a windward Hawaiian valley: Halawa Valley, Molokai. Pacific Anthropological Records, 24.

Lewis, E. 1970. The Campbell project: A preliminary report. Manuscript prepared for graduate seminar in Anthropology, University of Hawaii at Manoa. Honolulu.

McCoy, P.C. 1976. Easter Island settlement patterns in the late prehistoric and protohistoric periods. Easter Island Committee of the International Fund for Monuments, Bulletin 5.

Newman, T.S. 1970. Hawaiian fishing and farming on the island of Hawaii in A.D. 1778. Division of State Parks, Department of Land and Natural Resources, State of Hawaii. Honolulu.

Olson, S.L., and H.F. James. In Press. Prodromus of the fossil avifauna of the Hawaiian Islands. Smithsonian Contribution to Zoology.

Riley, T.J. 1973. Wet and dry in a Hawaiian valley. Ph.D. Dissertation in Anthropology, University of Hawaii at Manoa. Honolulu. (Unpublished).

Sinoto, A. 1976. A report on cultural resources survey at Barbers Point, Island of Oahu. B.P. Bishop Museum Manuscript Report 122476. Honolulu.

Spencer, J.E. 1966. Shifting cultivation in Southeastern Asia. University of California Publications in Geography, Vol. 19.

Vancouver, G. 1798. Voyages of discovery in the Years 1790-1795. London: Robinsons and Edwards.